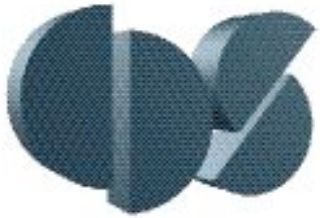
CS/EE/ME 75a
Collaboration Tools



Richard M. Murray

23 October 2006

Goals

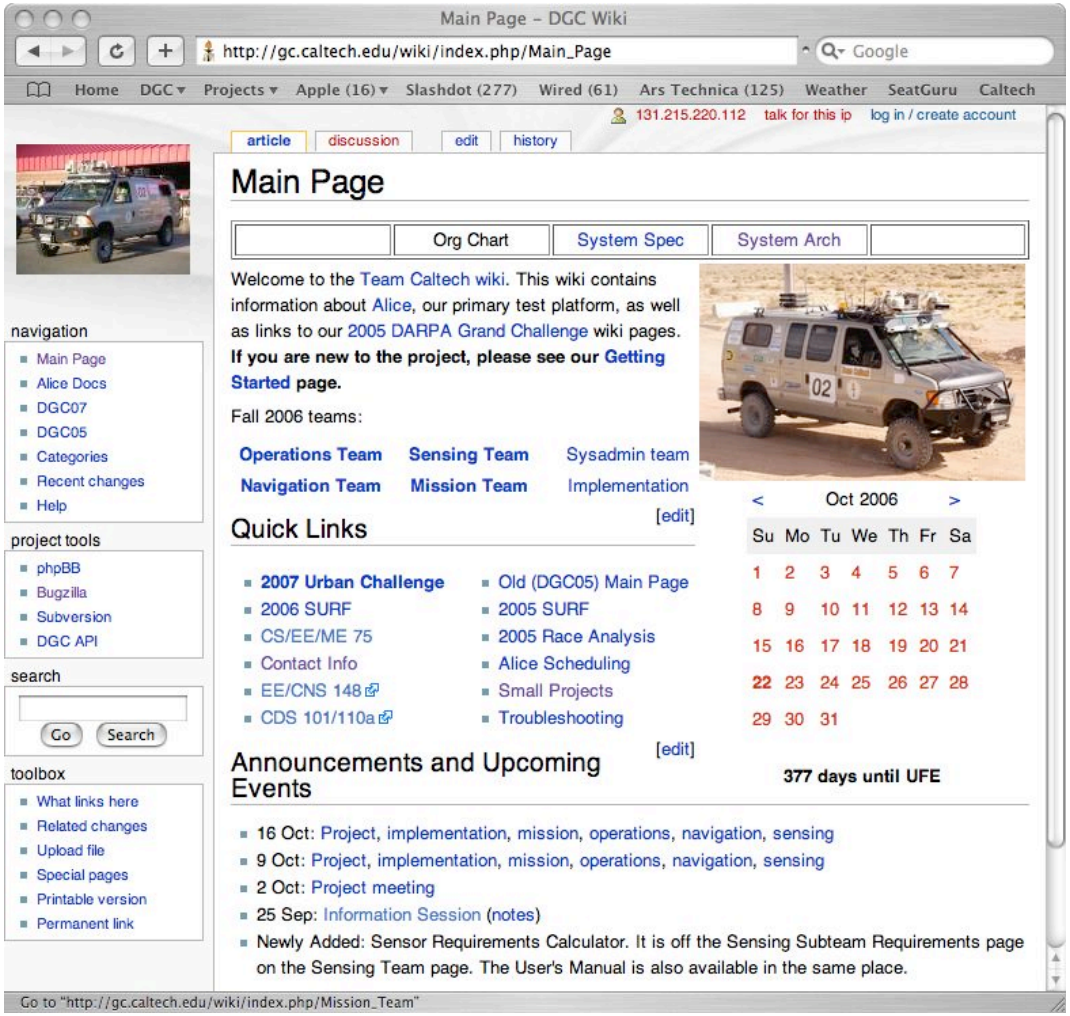
- Introduce the tools we will use for working across teams and subteams
- Review the information that we presented to DARPA

Agenda

12:00 Goals, agenda and notetaker
12:05 Collaboration tools: wiki, bugzilla, mailing lists, best practices
12:30 DARPA contract presentation
12:55 Adjourn

HW #3 due at 5 pm; HW #4 available on the web

Wiki



Group web page

- Keeps track of all notes and documentation on the project
- Can be edited by anyone with an account
- Allows searching, linking, figures, etc

Conventions

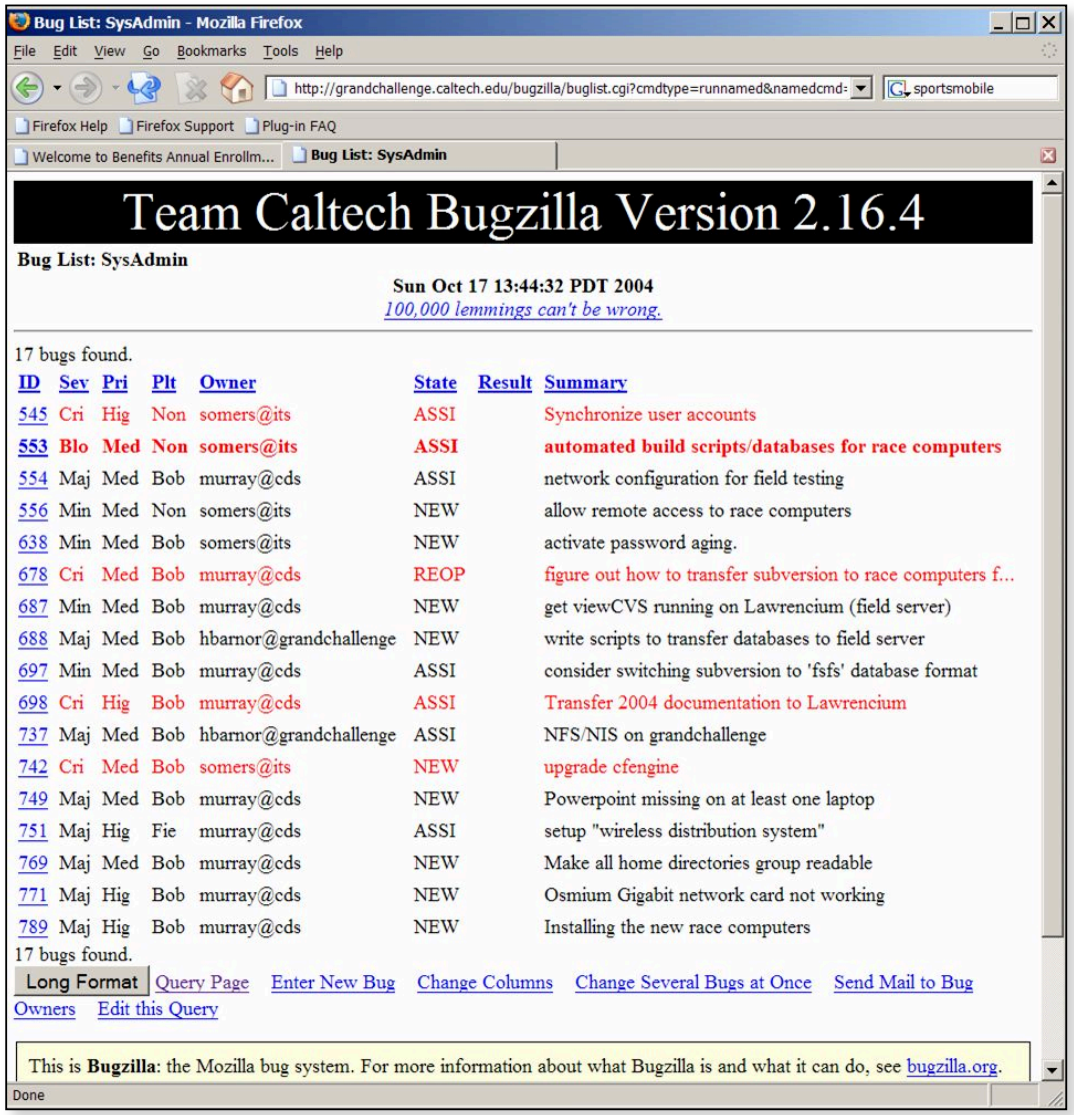
- Make your page titles description and unique
- Dates: 2006-10-23 at end of title

Advanced Features

- Watch lists - get e-mail when pages change
- Templates: allow you to include macros on pages

http://gc.caltech.edu/wiki

Bugzilla



Bug/task tracking tool

- Keeps track of all open tasks
- Sends e-mail to reporter, owner, CCs when changed
- Can set severity, depend bugs, current status, etc

2005 usage

- 2776 bugs in database
- 97 currently active
- 58 marked new (unassigned)

Planned usage

- Use to keep track of all open bugs/times for Team Caltech
- All team members need accounts + familiarity

http://gc.caltech.edu/bugzilla

Mailing Lists, Alice Docs, Coding standards

Mailing lists

- *team-students*: everyone actively working on the project; 1-2 msgs/day
- *team-volunteers:* part-time volunteers (usually off campus); 1-2 mgs/ week
- *help:* sys admins
- Race team lists: *mission, navigation, operations, sensing* - use to communicate with team

Usage notes

- Messages will be held for approval if you aren't on the list (or use a different e-mail)
- Don't assign a bug to a mailing list (OK to cc)

Alice documentation

- All projects, modules, libraries, etc should have a wiki page
- Top level documentation on Alice goes on the Alice documentation page
- Checklists: use to keep track of what needs to be done to run Alice

Usage notes

- Need someone (group?) to think through wiki guidelines
- If you see an obsolete page, mark as obsolete and merge info onto proper page

Coding standards

- Use standard linux tools (makefiles, gdb, etc)
- All code goes in subversion repository
- Code format and guidelines documented on the wiki: [[Coding Standards]]
- Classes and functions documented using *doxygen*; API documentation available on the web

Best Practices for Teams

Meetings

- Meetings should be announced via e-mail ahead of time, with goals and agenda
- Agenda item #1: goals and agenda
- Someone should be designated to take notes and post to wiki

Documentation

- Documentation is *critical* if you want your work to be used by others
- Don't wait until the end to document; document as you go
- All documentation belongs in the Wiki (searchable, revision tracking, etc)

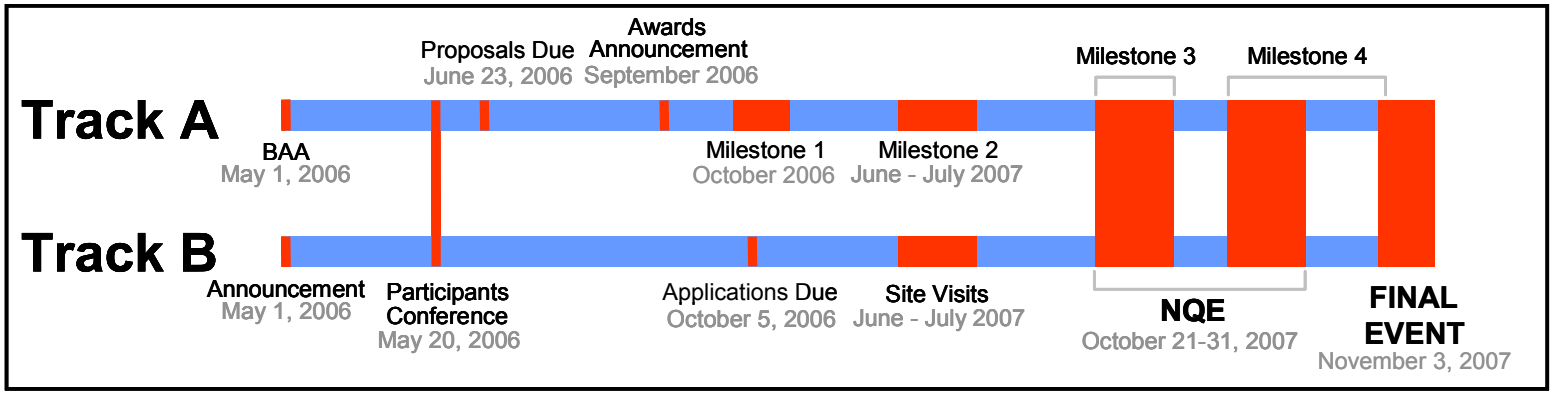
Subversion

- All source material (code, design, anything that changes over time) should be archived via Subversion
- We will use YaM on top of subversion to manage our code base
- More on using Subversion/YaM in a few weeks

Bugzilla

- Use bugzilla to keep track of all tasks and status on tasks
- Update bugzilla entries before team meetings, when possible
- More on Bugzilla next week

2007 Urban Challenge Participation



Track A: $1M grant from DARPA

- Proposal due 23 June 2006; up to $1M + any additional fundraising
- Award based on technical approach, management and funding plan, strength of team

Track B: no DARPA funding; similar to last year (application, site visit, NQE, GCE)

- ~~$50K award for getting to NQE, $100K award for getting to race~~
- Application due 5 Oct, with video, technical paper due in Feb 07; site visits in Jun 07

Changes from last year

- Use of government resources OK with permission from sponsors

H.R. 5122 Sec. 252 (Oct 06): DARPA not allowed to give prizes; shifted to DDR&E

Program Overview

Team Caltech: Caltech/JPL and Northrop Grumman

- Caltech campus: Faculty, students and staff
- Caltech JPL: Robotics and software researchers
- Northrop Grumman: Navigation, systems engineering

Key Deliverables

New technologies for mission and contingency management

- Reason about complex, uncertain, spatio-temporal environments
- Decision-making for safe and efficient execution of autonomous missions
- Contingency planning for operation in complex uncertain positions

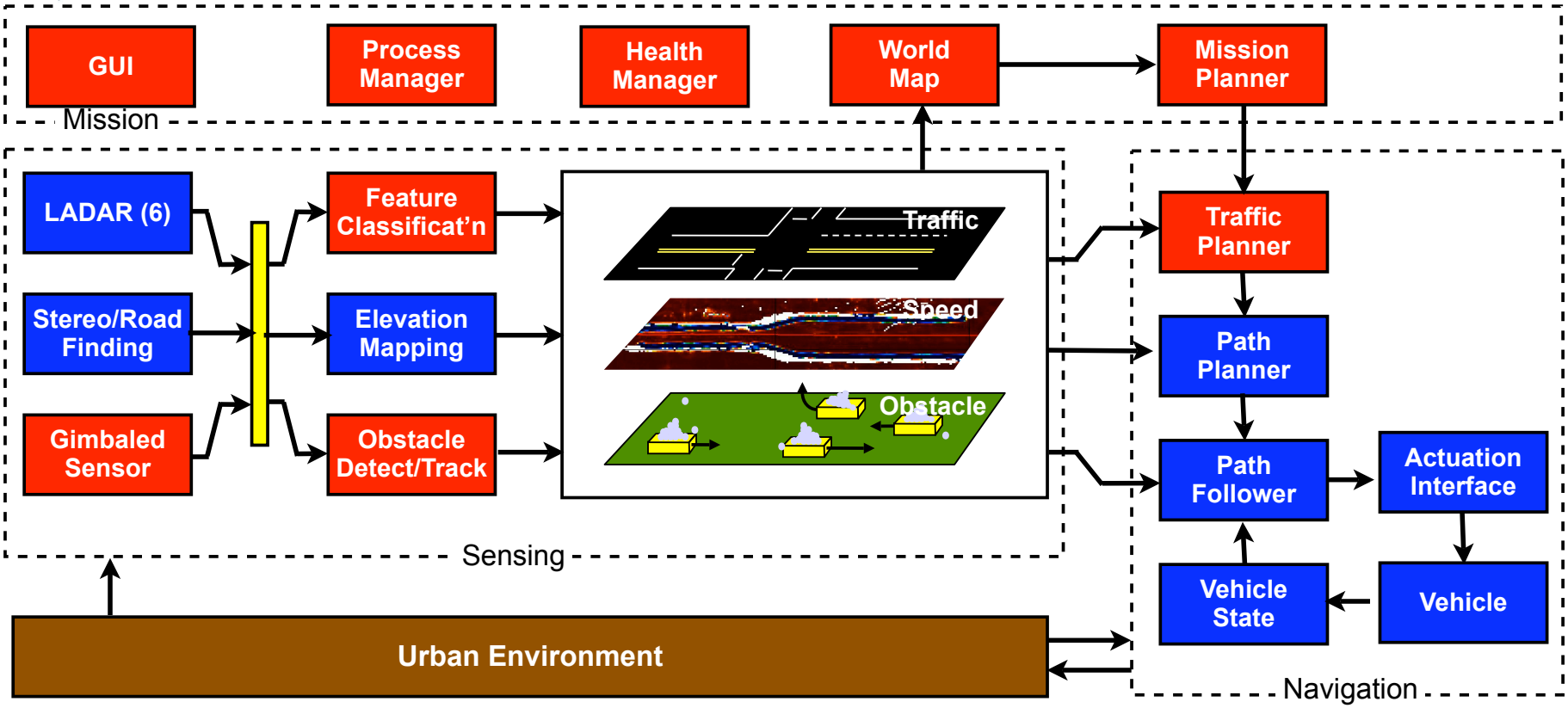
Distributed sensor fusion, mapping, and situational awareness

- Extend prior work at Caltech/JPL to work in a highly dynamic, urban environment
- Multi-layer decomposition of sensed environment with multi-level planning

Real-time, optimization-based navigation

- Extend previous work at Caltech/NGC to handle moving vehicles, traffic laws

Vehicle Development Plan: Overview



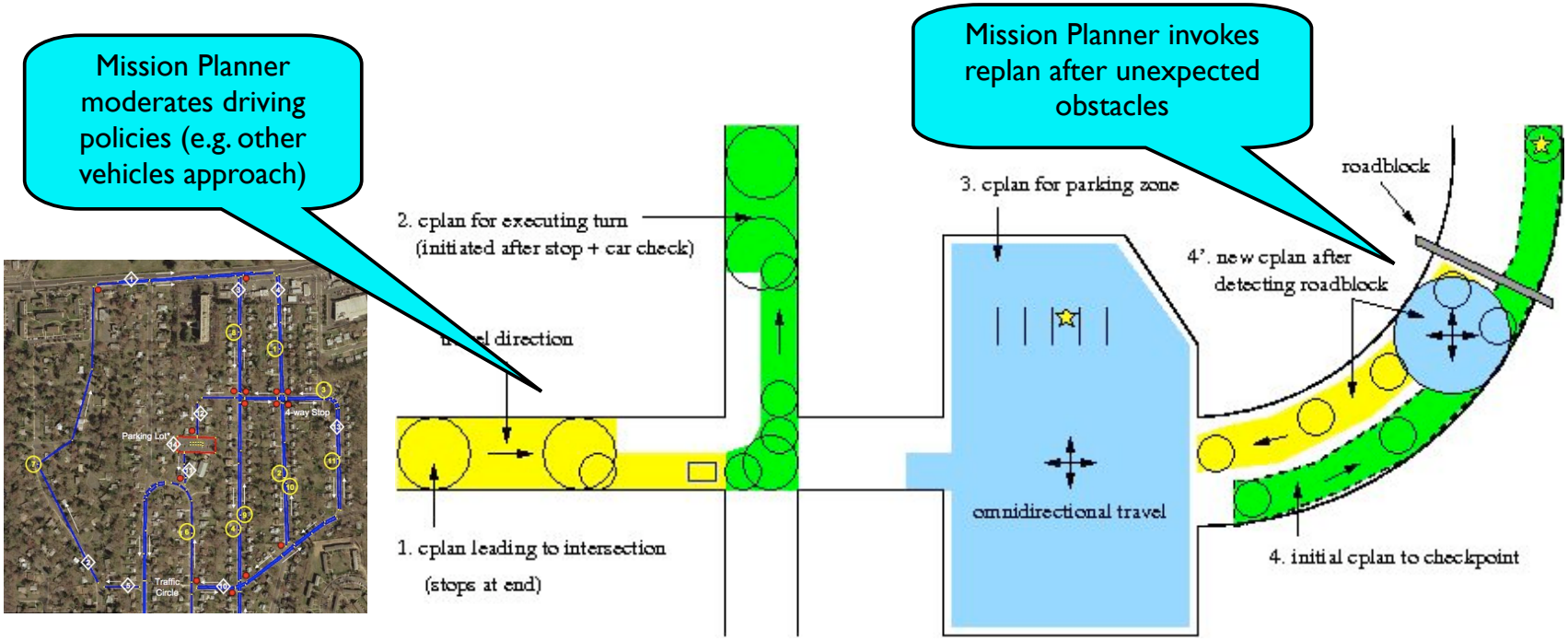
Key technical areas (focus of new research)

- Reasoning: decision making in presence of uncertainty
- Sensing technologies: characterization, detection, tracking, fusion
- Planning technologies: route, traffic, path

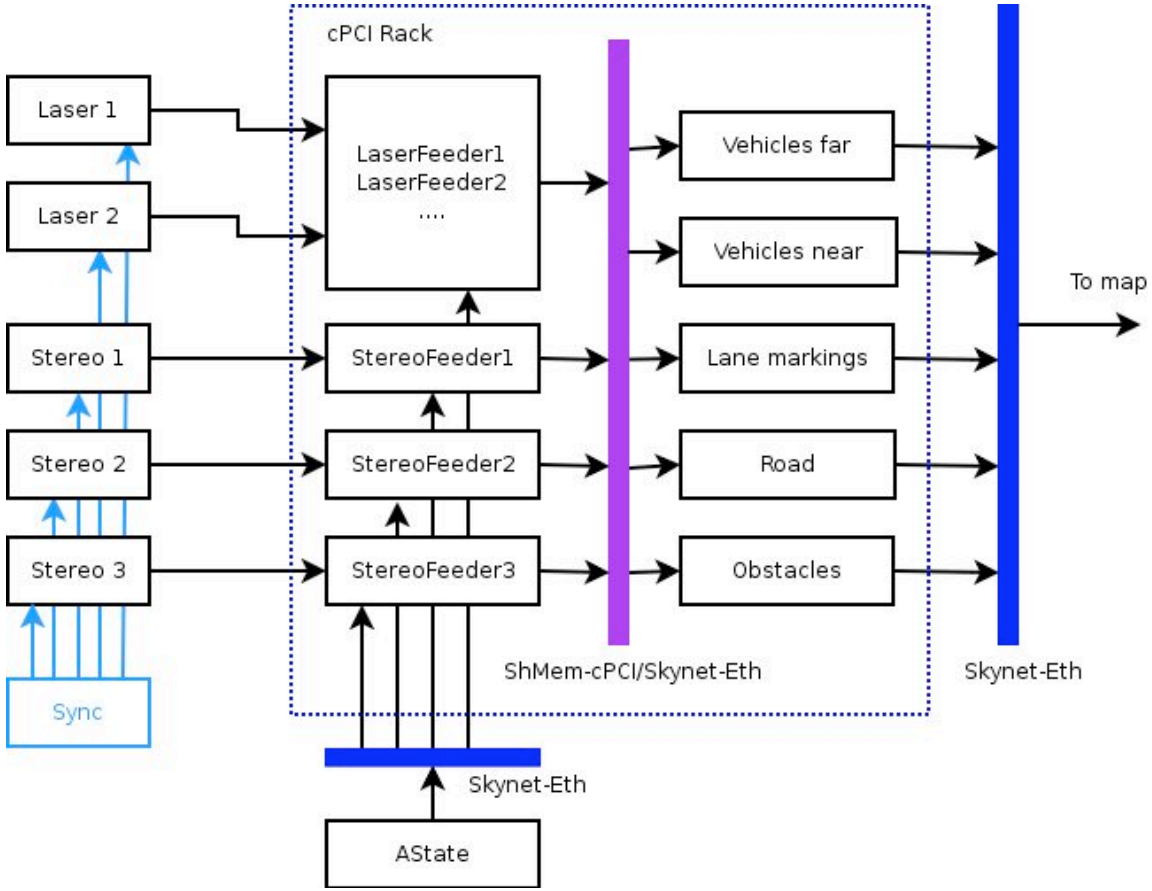
Mission Management

- **Mission Planner performs high level decision-making aka mission management**
- **Roadblock → Execution failure → Mission manager invokes path replanning**

- **Critical capability for dealing with other agents in traffic**
  - Will control execution of path following & planning (multi-point turns)
  - Will encode traffic rules
  - Will coordinate vehicle avoidance strategies (passive, active avoidance)



Sensing



Hardware

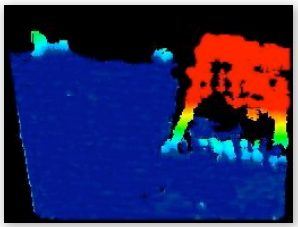
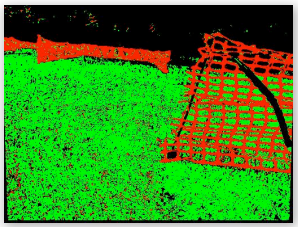
- LADAR/LIDAR/lasers, stereo vision, RADAR?
- Dedicated hardware interfaces (serial, ethernet, firewire)

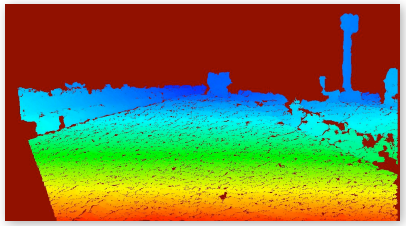
Feeders

- First level software interface; extract low level features: pt clouds, range, ...

Perceptors

- Extract higher level features: lanes, cars. elev



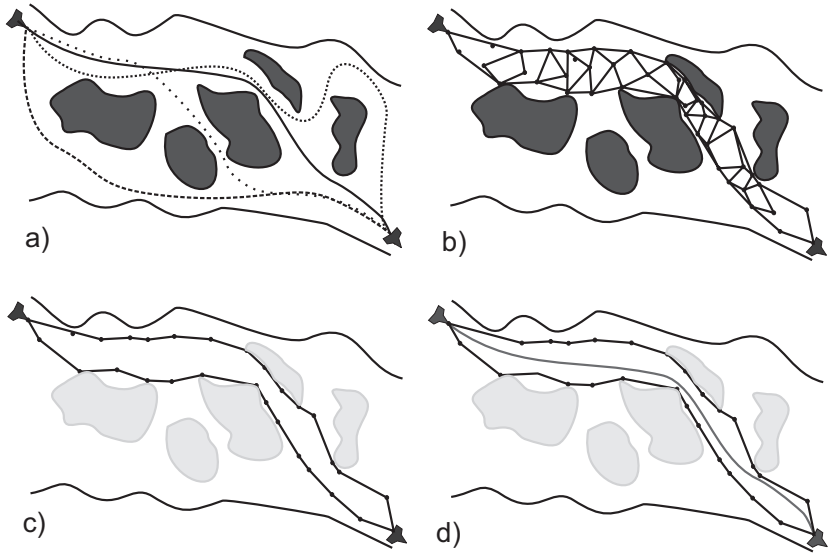
Optimization-Based GNC

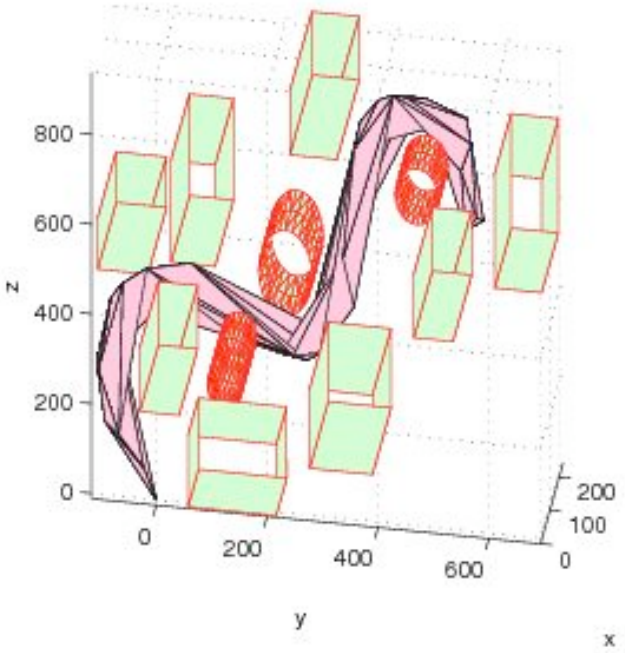
Build on previous research at Caltech and Northrop Grumman

- Nonlinear trajectory generation (NTG) software developed under DARPA SEC
- Software tested on F-14/T-33 testbed (SEC) + DGC05

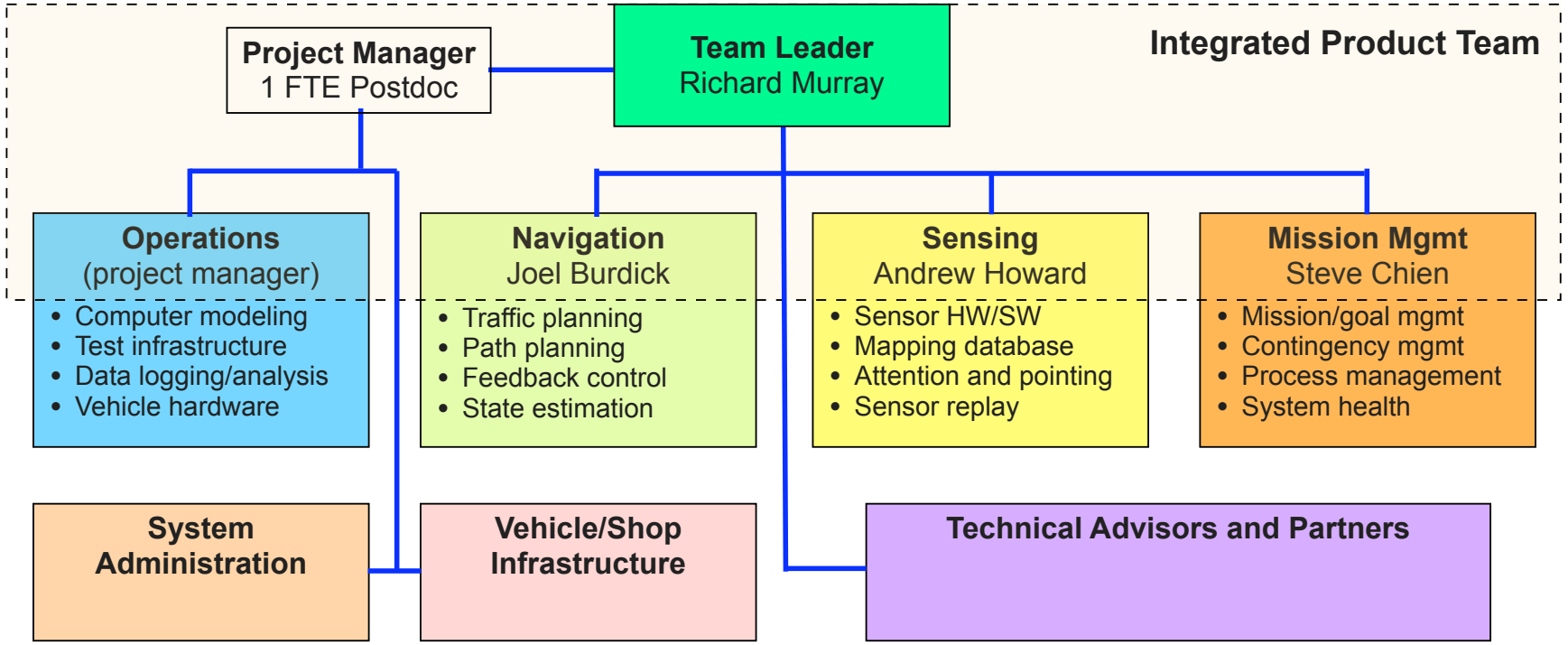
Extensions using NURBS (Non-uniform rational B-splines)

- Allows specification of spatial constraints with all paths lying in convex hull
- NGC to develop technology in-house and transition to Alice





Management Plan



Implement

DARPA contract support ($1M)

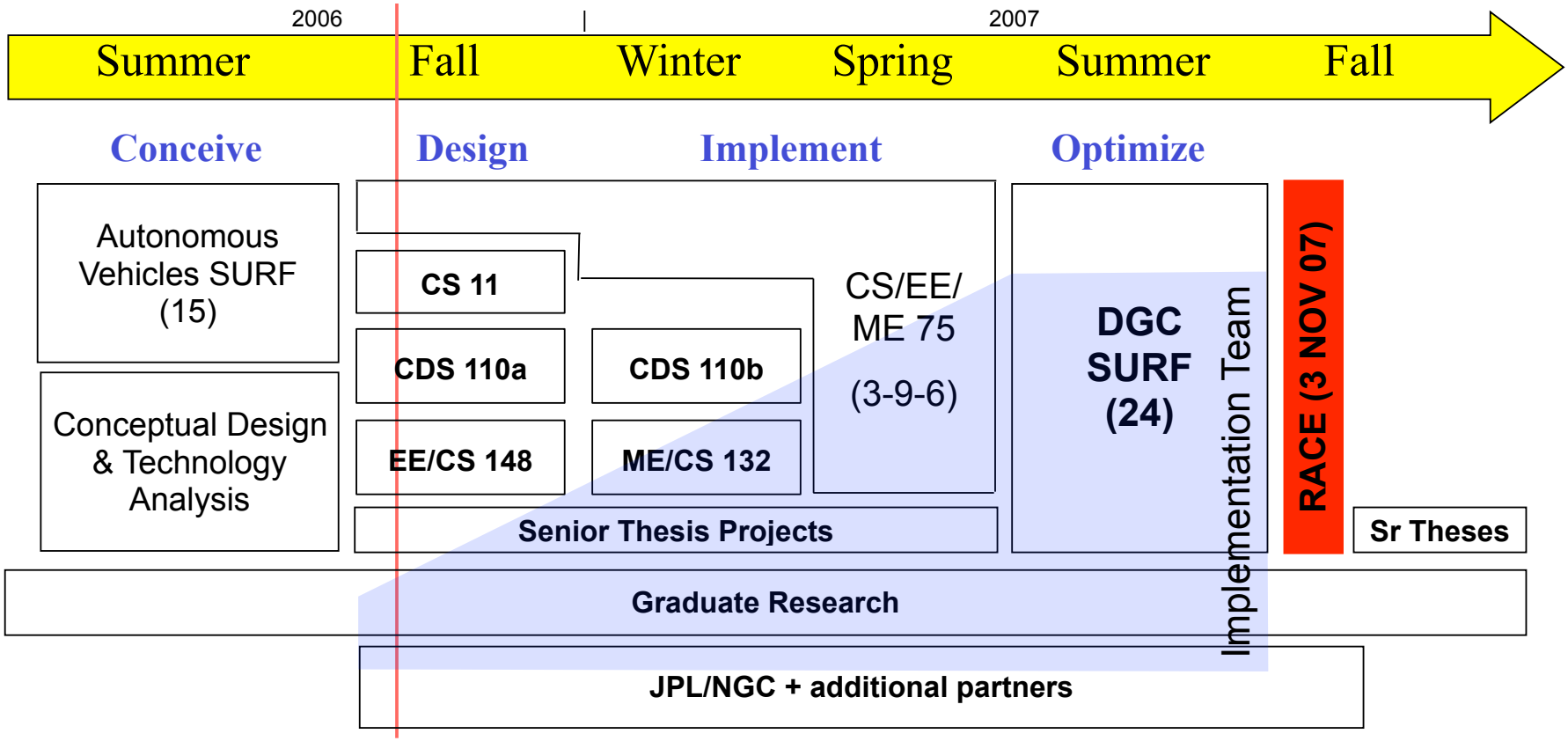
- 1 FTE postdoc (project manager)
- 4 FTE graduate students
- 1 FTE JPL reseacher
- 6 UG work study
- ~$150K equipment, $30K operations

Additional support ($300K)

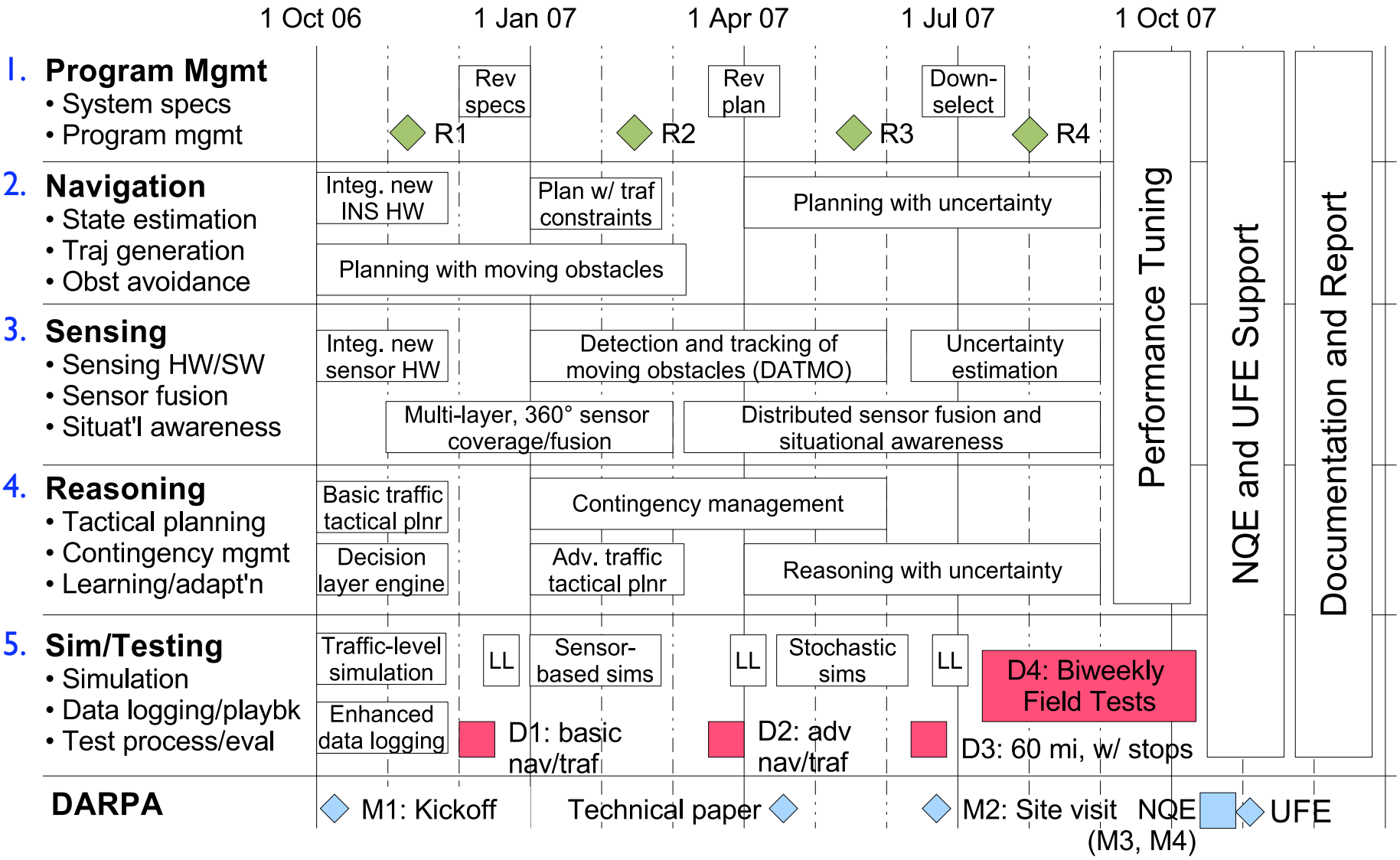
- 4 Caltech faculty, 30-40 UG (teaching)
- ~1 FTE NGC (internally supported)
- ~1 postdoc (industry), 4 GRA (fship)
- 12-24 SURF students (industry)
- $175K equipment (INS, sensing)

Team Caltech, 2006-07

Goal: design, build and document an autonomous ground vehicle that can win the 2007 Urban Challenge



Project Timeline



Internal Demonstration D1

Goals

- Demonstrate the ability to accomplish the basic navigation tasks
- Primary focus will be the ability to obey the rules of the road
- Provide initial evaluation of the fused static mapping and road maps, as well as the integration of road rules into the route, traffic and path planning modules

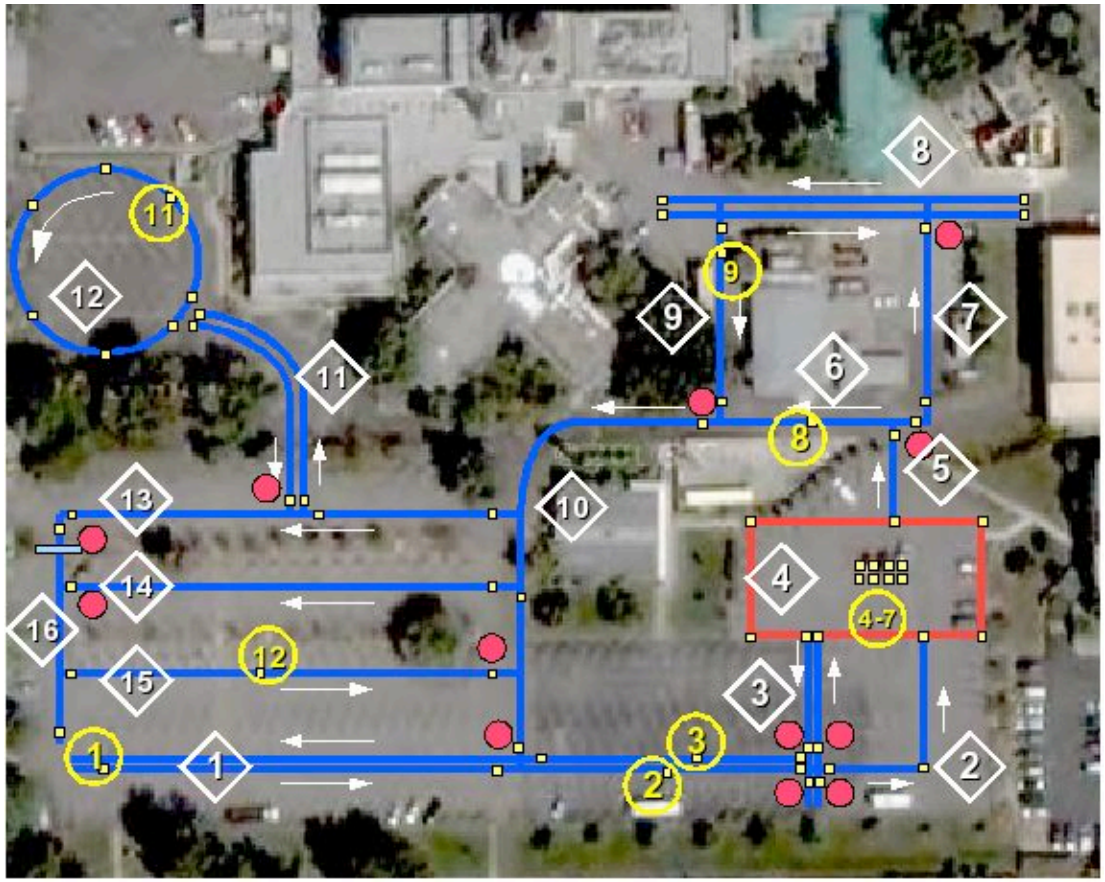
Specific objectives:

- Preparation for run and mission start (A1, A2)
- Basic path planning/following capability (A3, A4, A5, A8)
- Acceptable delay (A6) - begin execution of path w/in 10 sec of arriving at intersection
- Basic obstacle avoidance (A7, A9) - maintain proper separation, avoid collisions
- Lane maneuvers (A10, A11) - pass vehicle while maintaining separation, lane rules
- U-turn (A12): perform a U-turn on a 9 meter wide road within a 30-meter road length
- Road following (C5): demonstrate ability navigate roads with sparse waypoints

Implementation Review: 15 Nov 06

Field test: 11-12 Dec 06

Test Facilities



St. Luke test site

- Caltech owned properly; about 15 minutes away
- Provides a small test area where we can do development, benchmarking, etc
- Provides power, networking, facilities, security, etc
- Some scheduling issues due to use by filming companies (eg, today)

Santa Anita test site

- Large parking lot within 15 minutes of Caltech

Additional test sites and plans

- Exploring possibilities for using “movie ranch” (eg, 1950s town) or county fair area
- Joint testing with Golem group

Independent Test Team (ITT)

Testing Philosophy

- All testing is done using the RNDF and MDF file formats as input
- Ensures that parsing of the data files is a fundamental part of all tests
- All possible navigation instances are handled in at least a rudimentary way
- ITT doesn't test code; tests capabilities
- All ITT developed tests are available for regression testing
- Basic set of unit tests will be available for all test sites

Test Suites

- Four Test Suites: (1) Basic Navigation, (2) Traffic Interaction and Obstacle Avoidance, (3) Traffic Law Compliance and (4) Mission Level Testing
- Each suite ranges from unit tests to complex combinations
- Mission Level Testing combines elements from the first three

Field Trials

- Based on Technical Evaluation Criteria
- December 06 - Basic navigation
  - A1-A12, C5 (Road following with sparse waypoints)
- March 07 - Basic Traffic and Advanced Navigation
  - B1-B4, C1-C6
- June 07 - Advanced Navigation
  - D1-D9 + 60 Mile Test
  - DARPA Site visit
- Summer 07 - Bi-Weekly Field Tests
  - Final preparation for race
  - Handle issues from previous tests

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